Airway clearance techniques in bronchiectasis

Ashwin Basavaraj, M.D.

ABSTRACT

Background: *Chest physiotherapy is an important management strategy for patients with bronchiectasis. Impaired mucociliary clearance in bronchiectasis can lead to inflammation and chronic infection, which further perpetuates lung destruction in a vicious vortex pattern. Various techniques, including airway clearance techniques, mucoactive agents, and exercise may help to mobilize mucus from the airways in hopes of reducing inflammation and infection. The goal of chest physiotherapy in patients with bronchiectasis is to improve symptoms, reduce exacerbations, and improve quality of life. This is a review article summarizing airway clearance in bronchiectasis.*

Methods: *As part of this review, a literature search was performed that used PubMed. Search terms included "bronchiectasis," "airway clearance," "mucoactive therapies," "positive expiratory pressure device," "high-frequency chest wall oscillation," "nebulized hypertonic saline," "pulmonary rehabilitation." Terms were searched in combination as well as individually and were limited to those articles that reviewed bronchiectasis.*

Results: *A number of international guidelines in bronchiectasis recommend the use of chest physiotherapy. However, the data to support these recommendations are scarce and are often based on expert opinion. Moreover, existing literature with these modalities are often conflicting, further supporting the need for high-quality research in airway clearance.*

Conclusion: *Airway techniques in bronchiectasis is an important management strategy in patients with bronchiectasis. This manuscript provides a concise review of chest physiotherapy in bronchiectasis, and emphasizes the need for future research in this area.*

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Bronchiectasis is defined by irreversible dilatation of the airways and is associated with neutrophilic inflammation, with subsequent formation of neutrophil extracellular traps.[1,2] In bronchiectasis, mucus is often abnormal and more complex, which further contributes to mucus stagnation.[3] Impaired mucociliary clearance in bronchiectasis can lead to inflammation and chronic infection, which further perpetuates lung destruction in a vicious vortex pattern.[4] With this, bronchiectasis is often associated with progressive symptoms and worsening quality of life.[5] Airway clearance techniques (ACT) are modalities that help to mobilize retained mucus from the airways in hopes of breaking the vicious cycle of inflammation and infection. Removing purulent secretions from the airways may ameliorate the inflammation that develops and improves control of symptoms such as sputum production and mucus plugging. The goal of ACTs is to improve symptoms, reduce exacerbations, and improve quality of life.[6] Whereas more randomized controlled trials are needed to support the use of ACTs, international clinical guidelines (*i.e.*, British Thoracic Society, European Respiratory Society, and Thoracic Society of Australia and New Zealand)[7–9] have recommended ACT as a key component in the management of bronchiectasis. This review highlights the modalities available for chest physiotherapy in bronchiectasis, including ACTs, mucoactive therapies, and pulmonary rehabilitation and exercise. Evidence that supports chest physiotherapy use will be discussed as well as an emphasis for future research in this area.

METHODS

As part of this review, a literature search was performed that used PubMed. Search terms included "bronchiectasis," "airway clearance," "mucoactive therapies," "positive expiratory pressure device," "high-frequency chest wall oscillation," "nebulized hypertonic saline,"

From the Division of Pulmonary, Critical Care and Sleep Medicine, New York University Grossman School of Medicine, New York, New York

A. Basavaraj has served as a consultant and on the advisory board for Insmed, Hill-Rom, Zambon, Dymedso and Physio Assist; he also provided CE education via Tactile

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Address correspondence to Ashwin Basavaraj, M.D., New York University Grossman School of Medicine, 462 First Avenue, Administration Building, OBV, A601, New York, NY 10016

E-mail address: Ashwin.basavaraj@nyulangone.org

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"pulmonary rehabilitation." Terms were searched in combination as well as individually and were limited to those articles that reviewed bronchiectasis.

TYPES OF ACTs

ACTs include the use of manual techniques, such as manual chest physical therapy, chest percussion, postural drainage, autogenic drainage, and active cycle breathing techniques. ACTs also include instrumental techniques, such as positive expiratory pressure devices and high-frequency chest wall oscillation. The positive expiratory pressure device consists of a one-way valve and an adjustable expiratory resistor. A manometer is incorporated to measure the applied expiratory pressure. Tightening the expiratory resistor decreases the ability of flow to move rapidly through the device, which increases expiratory pressure and creates vibrations and/or oscillations to help mobilize mucus out of the airways.[10] Studies in the positive expiratory pressure device, albeit small, have shown an improvement in health-related quality of life, sputum expectoration, and lung volumes.[11] High-frequency chest wall oscillation therapy uses external chest wall oscillations delivered to the chest through a fitted vest. Oscillations are delivered at variable intensities and frequencies. High-velocity airflow created by oscillations of the chest wall facilitates movement of mucus.[12] High-frequency chest wall oscillation therapy is often used in a sicker bronchiectasis cohort, with >50% being shown to have a severe modified bronchiectasis severity index score and >80% having a bronchiectasis exacerbation in the previous 2 years reported from the United States Bronchiectasis and NTM research registry.[13]

Although ACTs are recommended by international bronchiectasis guidelines, expert panel reports, and consensus statements, the use of these techniques are far from widespread. The United States Bronchiectasis Research Registry[14] reports the use of ACTs in 59% of patients with bronchiectasis and a productive cough. Other international registries, including the European Multicentre Bronchiectasis Audit and Research Collaboration and the Indian bronchiectasis registry,[15,16] report similar results. Moreover, rates of adherence to ACTs are low.[17] This may be, in part, due to the lack of high-quality randomized clinical trials that support the use of ACTs in bronchiectasis, the lack of provider awareness in prescribing ACTs, and the lack of access to ACTs. Research in this area is sparse and limited to small, single-center, retrospective studies. Clinical use of ACTs in bronchiectasis is often extrapolated from studies that involved patients with cystic fibrosis and chronic obstructive pulmonary disorder,[18] and should be interpreted with caution in the non–cystic fibrosis bronchiectasis population. However, analysis of the data that are published does suggest some clinical benefit with the use of ACTs in bronchiectasis. Murray *et al.*[19] reported an improvement in quality of life, expectorated 24-hour sputum volume, and exercise capacity in those using chest physiotherapy in patients with bronchiectasis. Nicolini *et al.*[12] showed an improvement in pulmonary function and quality of life in those using high-frequency chest wall oscillation therapy in bronchiectasis. Munoz *et al.*[20] noted an improvement in expectorated sputum volume, reduction in exacerbations, improvement in quality of life, and reduced cough impact in those using slow expiration with the glottis opened in the lateral position. Other studies, however, have shown less-positive results. Patterson *et al.*[21] demonstrated that there was no difference in lung function and sputum weight with an active cycle of breathing techniques versus a positive expiratory pressure device over a 10-14–day treatment period in 20 stable patients.[11] Cochrane Database reviews have also been performed that summarized data on ACTs and noted that recommendations are based on low-quality evidence. Due to the lack of high-quality data and conflicting results, the true clinical benefit of ACTs in bronchiectasis is largely unknown.

MUCOACTIVE THERAPIES

In addition to ACTs, mucoactive therapies can also be used to aid in sputum clearance and/or reduce mucus hypersecretion.[22] They should be considered if ACTs alone are not effective and should be used in conjunction with ACTs. The most common mucoactive therapy often used is nebulized hypertonic saline solution. Hypertonic saline solution helps to hydrate airway mucus and increases ciliary beat frequency, thereby improving airway clearance.[23,24] Results of studies do suggest that nebulized hypertonic saline solution is generally well tolerated and can help improve quality of life.[23,25] A small study showed that inhalation of nebulized hypertonic saline solution has a similar effect on risk of exacerbation, quality of life, and respiratory function test in comparison with an isotonic saline solution.[23] This leads to the question of whether there is true efficacy of the actual concentration of nebulized saline solution being used or is the act of sputum clearance alone that may be beneficial. Inhaled mannitol has also been studied for its potential role as a mucoactive agent. However, a study concluded that inhaled mannitol did not reduce exacerbation frequency, although there were improvements in time to first exacerbation.[26] Other agents, such as n-acetylcysteine and guaifenesin, have been used, but further data are needed to support their routine use. Finally, the use of recombinant deoxyribonuclease in patients with bronchiectasis is not advised by international guidelines due to a lack of benefit and the possibility of harm, with increased frequency of exacerbations and more-rapid decline in forced expiratory volume in 1 second.[27]

PULMONARY REHABILITATION AND EXERCISE

Pulmonary rehabilitation and exercise are also important components of chest physiotherapy and are recommended by consensus guidelines.[7–9] In general, pulmonary rehabilitation incorporates several exercise modalities (treadmill walking, cycle ergometry, weight lifting, and arm ergometry) as well as patient education. Exercise training programs are composed of these exercise modalities without an educational component. Pulmonary rehabilitation and exercise training programs are generally aimed at improving both upper-limb and lower-limb endurance, and are tailored to the needs of the individual patient.[6] Clinical trials with pulmonary rehabilitation in bronchiectasis, similarly small, have shown some benefit in patients with bronchiectasis, with improvement in symptoms, exercise capacity, reduced time to next exacerbation, total number of exacerbations, and quality of life.[28–30] Pulmonary rehabilitation is recommended for patients with bronchiectasis and have demonstrated that the benefits of rehabilitation are at least as good in bronchiectasis as in patients with chronic obstructive pulmonary disorder.[31] However, studies have found that the benefits of pulmonary rehabilitation in bronchiectasis may not be sustained long term, which suggests that rehabilitation may need to be continuous to achieve long-term benefits.[30,32] Also, given the lack of access to pulmonary rehabilitation, tele-rehabilitation may also be an option, with one study that suggest similar benefits seen to a center-based approach.[33]

There are a few currently ongoing studies that are attempting to address the gap in chest physiotherapy research. One of these studies is the clinical and cost-effectiveness of hypertonic saline (HTS 6%) and carbocisteine for airway clearance versus usual care (CLEAR) trial study, a 52-week, two-by-two factorial, randomized, open-label trial to determine the clinical and cost-effectiveness of 6% hypertonic saline solution and carbocisteine for airway clearance versus usual care.[34] Another study is looking to use a combination of bicarbonate, glutathione, and ascorbic acid for airway clearance in bronchiectasis, previously showing benefit in cystic fibrosis.[35] Given the current paucity of high-quality data with chest physiotherapy in bronchiectasis, there is an urgent need for high-quality randomized trials. Studies that evaluate the clinical efficacy of ACTs in bronchiectasis have also been defined as a high research priority by international expert consensus groups.

CONCLUSION

Chest physiotherapy is an important strategy in the management of bronchiectasis. Although recommended by a number of international guidelines and expert opinion, literature that supports the use of chest physiotherapy in bronchiectasis however is lacking. Future studies are needed to further investigate the optimal approach and the true clinical benefit of airway clearance in bronchiectasis.

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